VTT Technical Research Centre of Finland

Biomaterial research at VTT- case nanocellulose

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Background – importance in Finland

- Forest products – paper & board, cellulose and timber- are among the most significant export items in Finland
- The demand of graphical papers has steadily decreased
  - P&P companies in need of new initiatives
- Research on **nanocellulose** started at VTT in 2008
  - Virtual Nanocellulose Centre between VTT – UPM – Aalto University
  - Customer project with Stora Enso on manufacturing concept
  - EU projects and national programmes on manufacturing and applications

Nanocellulose development - Pre-commercial production launched in 2011

UPM www-pages 11/2011

UPM HAS STARTED [illegible]MERCIAL PRODUCTION OF FIBRIL CELLULOSE

(UPM, Helsinki [illegible]2011 at 10.00) – UPM has started pre-commercial production [illegible]and is currently developing new fibril cellulose applications with ind[illegible]

U[illegible]ibril cellulose product development process in 2008. Pre-commercial [illegible]an this autumn at Otaniemi, Espoo, Finland. UPM is now able to provide [illegible]es of fibril cellulose for extensive customer testing. UPM's objective is to [illegible]e preconditions needed for industrial-scale production of fibril cellulose.

[illegible]ril cellulose is part of UPM's renewal and our Biofore strategy. We are currently focusing on commercialising fibril cellulose. The first stage mainly consists of developing products used in paper and packaging materials and the concrete and paint industries. We are also looking for new partners to develop new applications," says Esa Laurinsilta, Director, UPM Fibril Cellulose.

The production process used by UPM for fibril cellulose is [illegible] development. The fibres in the most finely grained products are [illegible] nano scale. The rougher products consist of micrometre fibres. UPM [illegible] results of the development work with comprehensive patents that cover the manufacture of fibril cellulose and the applications.

Fibril cellulose can be used in a wide range of applications. UPM's fibril cellulose provides new properties and design opportunities for traditional materials [illegible] to make products tougher, lighter or thinner, depending on the application.

When water is added to fibril cellulose, a strong gel structure is created. Therefore, fibril cellulose can be used in many industrial applications requiring high stabilisation capacity and high viscosity.

UPM's fibril cellulose has proved to be [illegible] several application tests over the past few years. "In October, we produced the [illegible]rial-scale batch of speciality paper reinforced with fibril cellulose at the UPM Tervasaari mill," Laurinsilta says.

Laurinsilta stresses the importance of the Finnish [illegible]ding Agency for Technology and Innovation (Tekes) and the development [illegible]s for the new product: "Forty researchers at the Finnish Centre for Nanocellulosic Technologies have developed fibril cellulose for UPM in cooperation with the VTT Technical Research Centre of Finland and Aalto University."

Development of industrial production with VTT

UPM

Stora Enso Packaging Newsletter 3/2011

The continuing development of renewable materials may open up many opportunities for us in the future. For instance components in vehicles like this could be manufactured out of materials containing microfibrillated cellulose.

MFC is a real step forward in renewable materials

Stora Enso is building a pre-commercial plant at Imatra Mills in Finland for the production of microfibrillated cellulose (MFC). This new type of renewable material is intended to be used in unique fibre-based board products, barrier materials and other viable future applications. The production of MFC is a significant step forward in innovative renewable materials.

"We envision that fibre-based packages enhanced with MFC can have excellent barrier properties that are suitable for both protection and printing but are manufactured from 100 percent recyclable material, with no fossil-based components," says **Jukka Kilpeläinen**, Senior Vice President of Stora Enso Group R&D.

MFC can be used as reinforcement in fibre-based packaging materials and in other materials because of its properties: good strength, bonding ability and slenderness. MFC may lead to the development of lighter and stronger materials and could increase the renewable content in Stora Enso's packaging solutions.

"Taking full advantage of the potential of MFC technology in fibre-based packaging materials requires making modifications to our current manufacturing processes and adaptations in other processes in the value chain, including efforts to develop the end-use experience of new products. This can now be studied carefully in full-scale conditions," says Jan Lif, Head of R&D and Innovation, Stora Enso Packaging.

MFC has been produced in laboratory environments since the 1980s, and several useful applications have been demonstrated. The challenge so far has been to lower its production costs to a level which would enable commercial usage. [illegible] now succeeded [illegible] pers[illegible] Vilnius, and with the R&D institutes Innventia (Sweden) and VTT (Finland), in creating a new technology to make MFC [illegible]ctive.

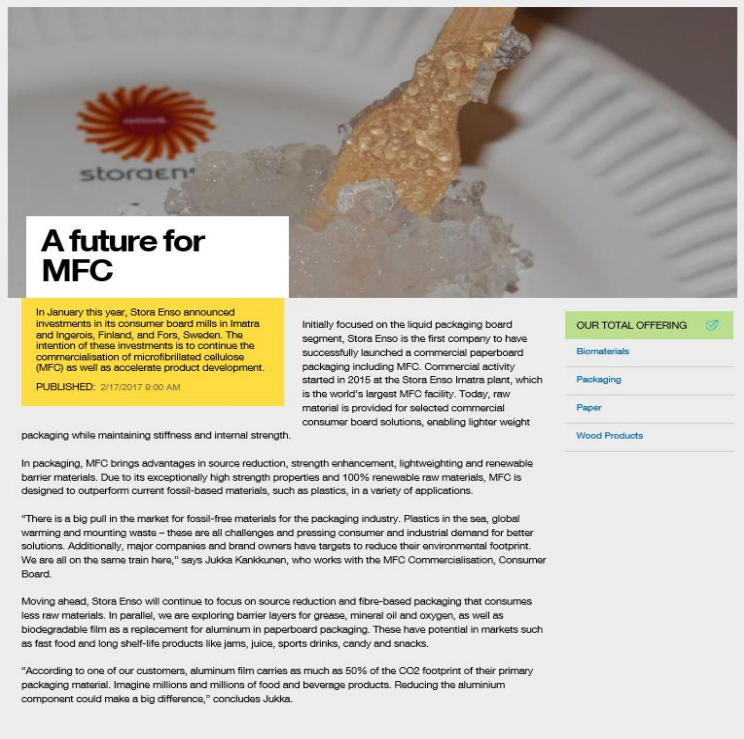
The cost of [illegible] microfibrillated cellulose technology, including the Imatra pre-commercial plant, is estimated at EUR 10 million. The plant is scheduled to start production by the end of 2011.

Key facts

- MFC particles are about a thousand times larger than any nanocellulose particles. Micro-sized cellulose particles do exist, for instance, in ordinary market pulp.
- Just like rope, which consists of longer and shorter threads, the cellulose fibre itself consists of fibrils and microfibrils. The microfibrils have a high degree of crystallinity and the mechanical properties are as strong as the glass fibres commonly used in epoxy-based advanced composites.
- In terms of their structural character, microfibrils are long in relation to their thickness, i.e. they have a high slenderness ratio, and even at a concentration of 2–4%, gel-like properties are observed, which makes it suitable as a consistency and flow regulator in many applications.

Stora Enso

News on nanocellulose applications 2017



A future for MFC

In January this year, Stora Enso announced investments in its consumer board mills in Imatra and Ingerois, Finland, and Fors, Sweden. The intention of these investments is to continue the commercialisation of microfibrillated cellulose (MFC) as well as accelerate product development.

PUBLISHED: 2/17/2017 9:00 AM

Initially focused on the liquid packaging board segment, Stora Enso is the first company to have successfully launched a commercial paperboard packaging including MFC. Commercial activity started in 2015 at the Stora Enso Imatra plant, which is the world's largest MFC facility. Today, raw material is provided for selected commercial consumer board solutions, enabling lighter weight packaging while maintaining stiffness and internal strength.

OUR TOTAL OFFERING

- Biomaterials
- Packaging
- Paper
- Wood Products

In packaging, MFC brings advantages in source reduction, strength enhancement, lightweighting and renewable barrier materials. Due to its exceptionally high strength properties and 100% renewable raw materials, MFC is designed to outperform current fossil-based materials, such as plastics, in a variety of applications.

"There is a big pull in the market for fossil-free materials for the packaging industry. Plastics in the sea, global warming and mounting waste – these are all challenges and pressing consumer and industrial demand for better solutions. Additionally, major companies and brand owners have targets to reduce their environmental footprint. We are all on the same train here," says Jukka Kankkunen, who works with the MFC Commercialisation, Consumer Board.

Moving ahead, Stora Enso will continue to focus on source reduction and fibre-based packaging that consumes less raw materials. In parallel, we are exploring barrier layers for grease, mineral oil and oxygen, as well as biodegradable film as a replacement for aluminum in paperboard packaging. These have potential in markets such as fast food and long shelf-life products like jams, juice, sports drinks, candy and snacks.

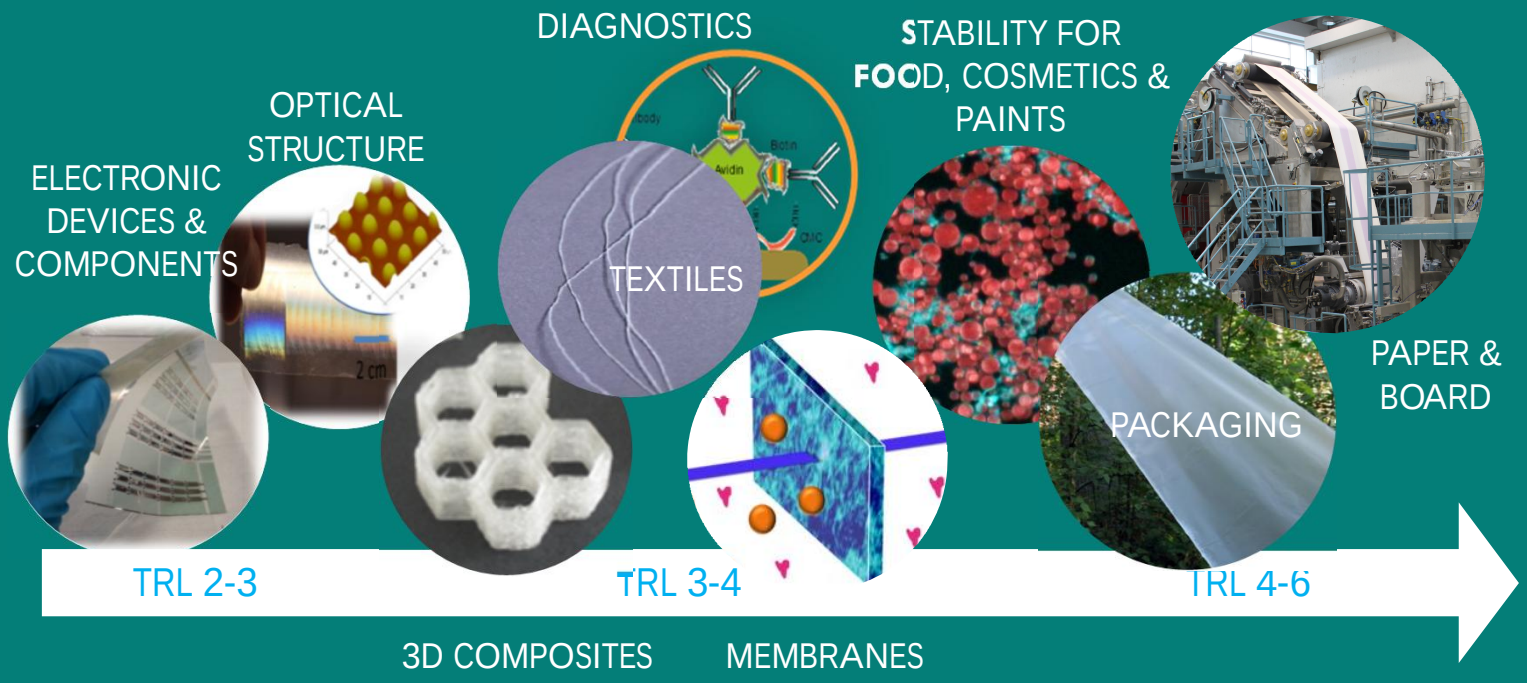
"According to one of our customers, aluminum film carries as much as 50% of the CO2 footprint of their primary packaging material. Imagine millions and millions of food and beverage products. Reducing the aluminium component could make a big difference," concludes Jukka.

Source: Stora Enso

- Biofibrils are products based on micro- and nano-fibrillated cellulose which give liquid product formulations new rheological characteristics or strengthen material properties.
- GrowDex® is a novel wood-based cellulose nanofibril hydrogel for 3D cell culturing and other biomedical applications. It is highly biocompatible with human cells and tissues – but without any animal- or human-derived material.

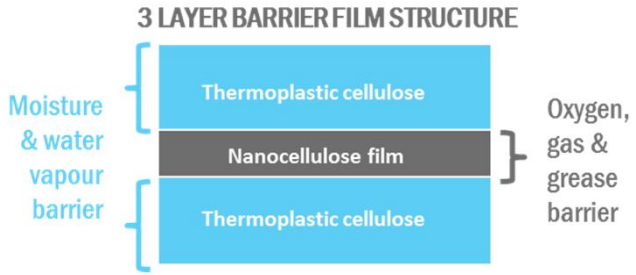
Source: UPM

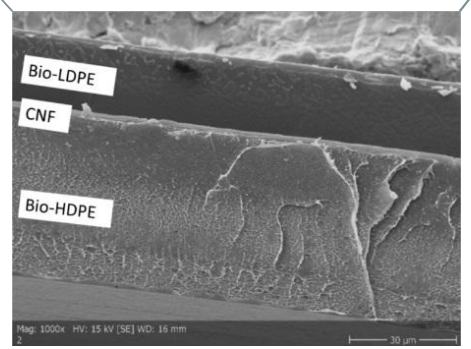
Nanocellulose APPLICATIONS
AT VARIOUS TRL LEVELS



Bio-based stand-up pouch (SUP)

BIO-BASED BARRIER SOLUTION FOR SUSTAINABLE PACKAGING





Drivers for advanced biomaterials & nanomaterials

EU bans single use plastics – potential alternatives from bio-based materials

Consumers prefer green solutions

Sustainable production

Abundant raw material

Utilisation of side streams

Biodegradability

Compostability

Challenges for advanced biomaterials & nanomaterials

- Use of forest must be balanced with their growth – limits for felling?
- Forests are needed as carbon sinks – IPCC report on global warming
- Recycling must be solved – biodegradation is not the priority
- Brand owners banning multimaterials that are not recyclable
- Need for investments if not processable with existing machinery
- Properties vs. price

NEW AND FUTURE INVESTMENTS

Metsä Group Äänekoski Bioproduct Mill
- Production 1,3 Million tons of pulp/a, wood use 6,5 million m3/a, production started 2017
- Investment 1,4 billion€

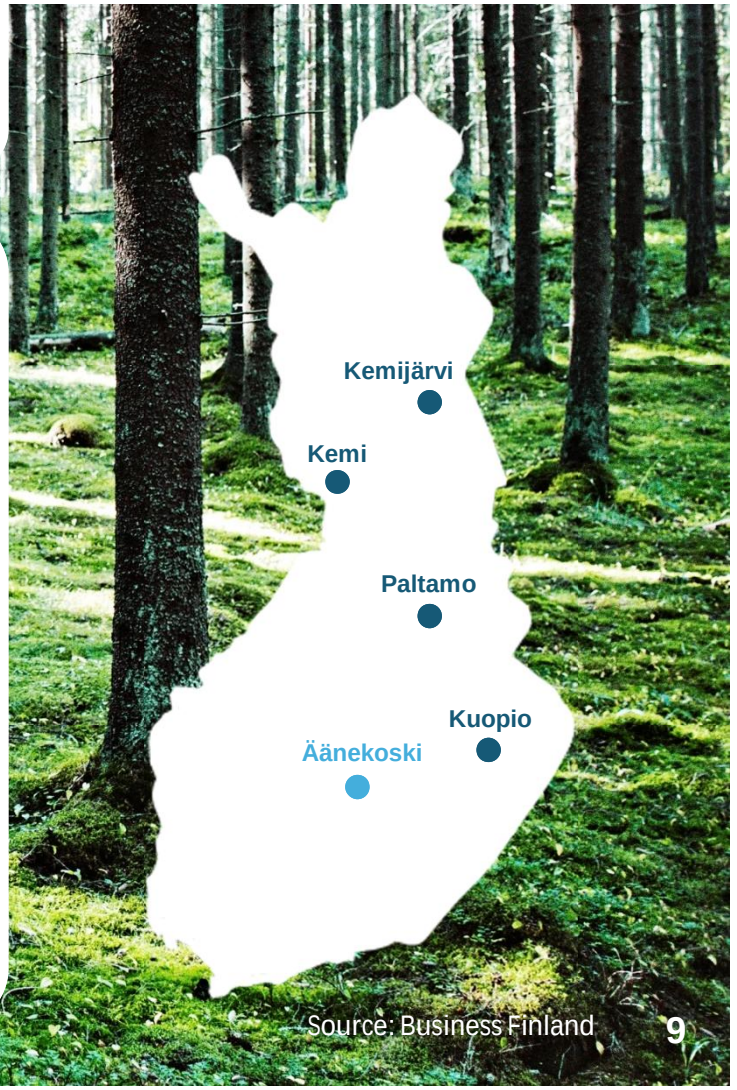
Renewal of Metsä Group Kemi pulp mill, 900 million€
- (Or building a new mill > 1 billion€), pre-study
- No investment decision yet

Boreal Bioref, Kemijärvi, building to be started summer 2018,
- Production 0,5 million ton of pulp/a, wood use 2,8 million m3/a, to start 2020,
- Cost 950 million€
- Main owner Chinese Shanying

Finpulp, Kuopio, softwood pulp & bioproduct mill, planning started
- Hengan International, tissue producer, as one of the minor stakeholders (investment 14 million€)
- Planned cost 1,4 billion€

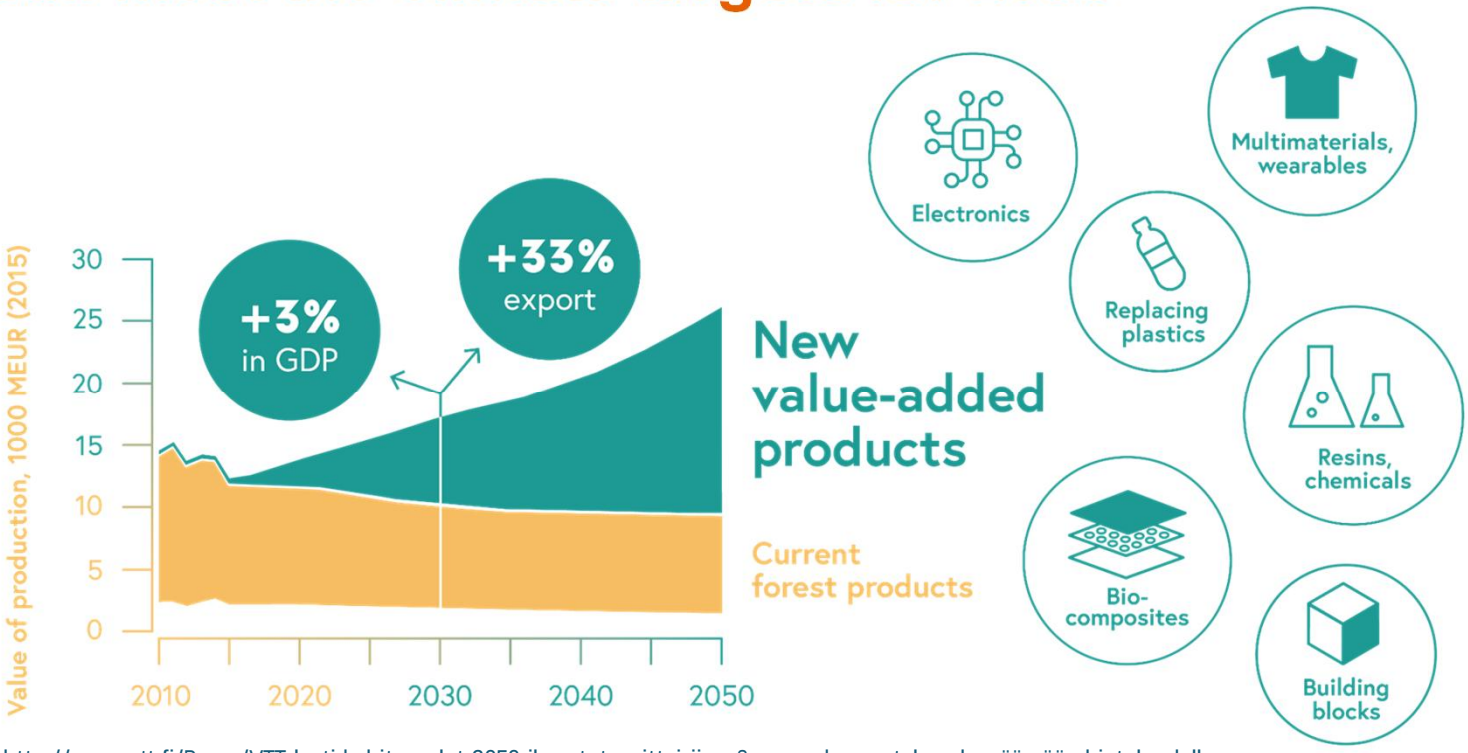
Kaidi Biorefinery, Kemi, car biofuels
- Investment decision (900 million€) waits for environmental permits & new EU directive for renewal energy
- One of the owners private Chinese Sunshine Kaidi New Energy Group

KaiCell Fibers plans to build a new pulp mill to Paltamo, no investment decision yet



Source: Business Finland

The value-added of forest industry can be doubled and *still* meet the climate targets for 2050



http://www.vtt.fi/Pages/VTT-laati-kehityspolut-2050-ilmastotavoitteisiin---Suomen-kansantalous-hyrräämään-biotaloudella.aspx